

What is the Capstone Design Project?

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Topics

- Capstone Design Project: concept
- Capstone Design Project: defined
- Design Project Criteria
- IE Senior Capstone Design Project
- **Capstone Design Project Learning Objectives and ABET Outcomes**
- Grading of design project
- Project Selection Procedures
- Capstone Design Project Proposal Form



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Capstone Design Project: concept



- ❑ It is a strategic course & a Mandatory in accredited engineering program.
- ❑ It provides senior engineering students *open-ended project experiences with a variety of realistic requirements and constraints.*
- ❑ It makes excellent environments for observing, cultivating, and documenting students' professional competencies and their achievement in support of program accreditation.

Capstone Design Project: concept



The capstone design course is a forum where the *non technical* as well as the *technical* aspects of success in an engineering career can be highlighted.

It is a way to challenge our students to develop their full range of skills, to be better engineers.

Capstone Design Project: concept

- The capstone design course is not just about finding a technical solution to a particular problem

but it is about

How can Student Work as Engineer Within A Project

Capstone Design Project: concept

- **One of the keys to make this happen is**
 - rewarding the students for excelling in all aspects of the course
 - **not just grading their technical solution.**
 - The reward system must match the wanted behavior!

Capstone Design Project: defined



➤ **What is a capstone? It means linguistically**
The crowning achievement (top stone of a structure)

What is Design? It means

“An ability to design solutions for complex, open-ended engineering problems for systems, components or processes that meet specified needs, considering realistic constraints such as applicable standards, health and safety risks, economic, environmental, cultural and societal, manufacturability, and sustainability”

Capstone Design Project: defined



➤ **What is Project? It means**

“An undertaking requiring concerted effort to create a unique work”

(An extensive task undertaken by a student or group of students to apply, illustrate, or supplement classroom lessons)

➤ **What is Capstone Design Project? It means**

“An undertaking a project work of a real-world, open-ended, and interdisciplinary engineering problems and applying lessons learned in realization and visualization of engineering problem, defining the problem and its functional requirements, project planning, engineering design process, selection between alternatives, analysis, identifying risks and countermeasures,, and physical prototyping”.

Capstone Design Project: defined



Capstone design project is concerned with 5 elements:

- (Project planning), Ability to plan and execute a project
- (Problem/project definition), Ability to address an engineering situation
- (Engineering design), Ability to find design alternatives and to select optimally and effectively within realistic requirements and constraints
- (Team work skills), Ability to work within team building meeting skill, and conflict resolution.
- (Communication skills), Ability to communicate in writing and orally building the communication, presentation, and interpersonal skills.

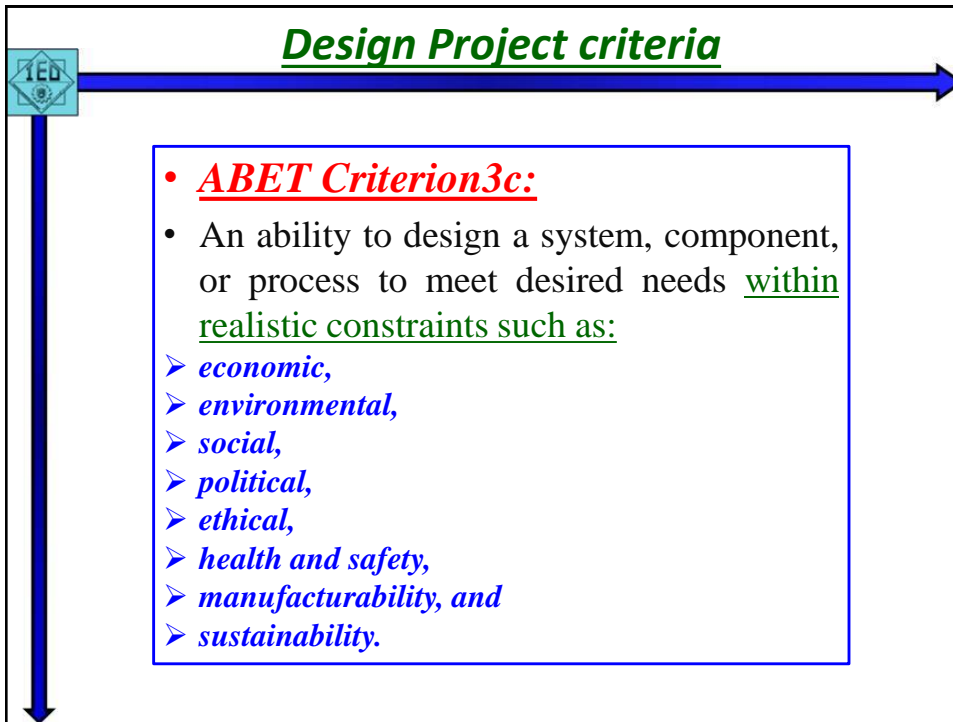
Design Project criteria

- Capstone design project is built on several design criteria based on:
 - ABET and
 - Professional Institutions.



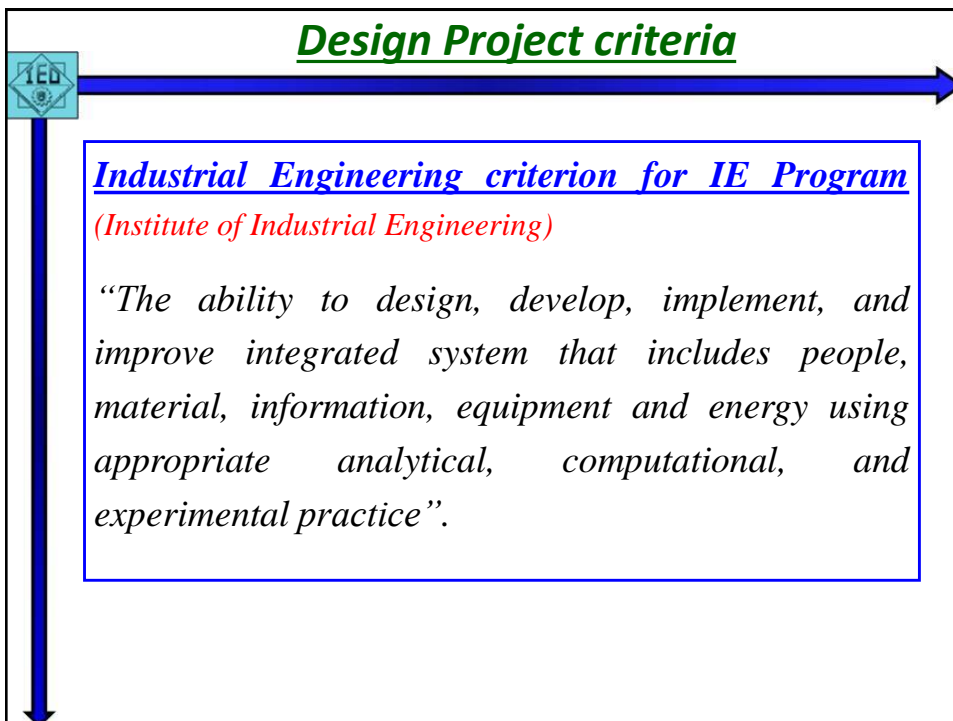
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Design Project criteria

- **ABET Criterion3c:**
 - An ability to design a system, component, or process to meet desired needs within realistic constraints such as:
 - *economic,*
 - *environmental,*
 - *social,*
 - *political,*
 - *ethical,*
 - *health and safety,*
 - *manufacturability, and*
 - *sustainability.*




Design Project criteria

Industrial Engineering criterion for IE Program
(Institute of Industrial Engineering)

“The ability to design, develop, implement, and improve integrated system that includes people, material, information, equipment and energy using appropriate analytical, computational, and experimental practice”.


Design Project criteria



• **Manufacturing criterion for program include manufacturing** (*Society of Manufacturing Engineers*)

“The ability to design, process, assembly, product, equipment, tooling, systems and environment for manufacturing using and understanding knowledge of manufacturing planning, strategy, and control. (Understanding the analysis, synthesis, and control of manufacturing operations using statistical and calculus; simulation and information technology; laboratory experience”.

Design Project criteria



• **ABET Criterion 5:**

- Students must be prepared for engineering practice through the curriculum culminating in a **major design experience** based on:
 - *the knowledge and skills acquired in earlier coursework, and*
 - *incorporating appropriate engineering standards and multiple realistic constraints.*

IE Senior Capstone Design Project

• **Based on the above criteria:**

- Design projects are design tasks for production systems and its components (manufacturing or service) . They are based on **Analytical and/or Experimental Base**

The design tasks can be one or more of the following elements:

- ***A process/ procedure,***
- ***Product,***
- ***A component, or***
- ***A system***

IE Senior Capstone Design Project


- **Project background (figure 1):**
 - Knowledge gained from the previous engineering sciences, design and laboratory course works.
 - Modern tools and techniques in the fields of IE

```

graph LR
    subgraph Science_and_mathematics [Science and mathematic courses, (12+23CH)]
        S1[CHM101, PHYS103, PHYS104, MATH140, MATH150, MATH106, MATH107, MATH203, MATH204, MATH244, STAT324]
    end
    subgraph General_engineering [General engineering courses, (15CH)]
        G1[GE104, GE201, GE211, GE302, GE403, GE404]
    end
    subgraph Engineering_sciences [Engineering sciences courses and design components, (48CH)]
        subgraph Engineering_design [Engineering design courses, (17CH)]
            E1[IE301, IE342, E360, IE450, IE461, IE469]
        end
        subgraph Capstone [Capstone Design Projects (4CH)]
            C1[IE496, IE497]
        end
        E1 --> C1
    end
    S1 --> E1
    G1 --> E1
    
```

Figure (1) IE program leading to capstone design project


IE Capstone Design Project




The project is given by two sequential courses

- IE 496: Project -1-; 2(1,1,2); 9th semester
- IE497: Project -2- 2(0,1,4); 10th semester


***IE - Capstone Design Project
Learning Objectives
and ABET Outcomes***



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IE 496 Project -1-




This part of the project prepares the senior students to carry a production design project for process, product, component, and/or system on the basis of the learned knowledge as follows:

- *Selecting a design project topic;*
- *Identifying the problem;*
- *Developing work plan;*
- *Formulating the problem through reviewing background and integrating knowledge;*
- *Preparing for/or preliminary conducting of the experiments;*
- *Collecting the field data and developing the mathematical model if applicable;*
- *Writing the first part along with any preliminary findings.*

IE496 Project -1-


Learning Objectives (LO) and ABET Outcomes



It is a preparatory stage: background, problem definition, problem formulation, and work plan (**8LO**)

- **LO1: Background review**; ABET Outcomes: **a, e**
- **LO2: Project identification and selection**; ABET Outcomes: **e**
- **LO3: Problem formulation**; ABET Outcomes: **e**
- **LO4: Design objectives and evaluation**; ABET Outcomes: **c**
- **LO5: Project planning**; ABET Outcomes: **e**
- **LO6: Work attitude** (a) Contribution to work and Taking responsibility; (b) Valuing other views and Conflict resolution; ABET Outcomes: **d, f**
- **LO7: Written communication skill** (a) Style, Formatting, Organizing & language neatness; (b) Contents & References; ABET Outcomes: **g, k**
- **LO8: Oral communication skill** (a) Style, Organizing, Visual aid & neatness; (b) Delivery skill & Audience response; ABET Outcomes: **g, k**


IE 497 Project -2-



This part of the project, the senior students implement a production design project for process, product, component, and/or system on the basis of the learned knowledge as follows:

- *Selecting appropriate design and/or experimental tools;*
- *Performing design/experiments;*
- *Performing analysis and evaluation of result;*
- *Interpreting and conclusions of results;*
- *Recommendation and future work*

IE497 Project -2-



Learning Objectives (LO) and ABET Outcomes

It is the Implementation stage: Implement a planned design strategy for either an experimental or a production-based design project or both (8LO)

- **LO1: Implementing project parameters and assumptions;** ABET Outcomes: **c, and/or b**
- **LO2: Design analysis and/or experimental design;** ABET Outcomes: **c, k**
- **LO3: Use modern engineering tools** to estimate and/or to explain a reliable experimental setup for obtaining the performance parameters and trade-off studies and a final optimized analysis; ABET Outcomes: **c, k**
- **LO4: Evaluation of relevant constraints** in particular environmental and health issues; ABET Outcomes: **f, h, i**
- **LO5: Evaluation of analysis of design criteria;** ABET Outcomes: **h, i, c and/or b**
- **LO6: Work attitude** (a) Contribution to work and Taking responsibility; (b) Valuing other views and Conflict resolution; ABET Outcomes: **d, f**
- **LO7: Written communication skill** (a) Style, Formatting, Organizing & language neatness; (b) Contents & References; ABET Outcomes: **g, k**
- **LO8: Oral communication skill** (a) Style, Organizing, Visual aid & neatness; (b) Delivery skill & Audience response; ABET Outcomes: **g, k**

IE - Capstone Design Project ***Grading of the design project***



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Grading of the design project

- ***Semester Grading (100marks)***
- Supervisor(s) set weekly group meetings to follow up project progress and assess student according as follow:
 - 1) Student absenteeism (***will be collected weekly by project coordinator***). ***Student absent over 25% will be barred***
 - 2) Setting at least one written quiz. (10 marks)
 - 3) Students submit at least one progressive report. (10 marks)
 - 4) Assessment of student outcomes by filling an assessment form
 - For Project Learning outcome ***LO1 to 5*** (50 marks)
 - For Project Learning outcome (work attitude) ***LO6*** (20 marks)
 - 5) Students self assessment (10marks)

IE 496 Project-1 Supervisor Assessment Form

The assessment is based on learning objectives for part 1 of the project which includes: problem identification, background review, and problem formulation (use of background and integrate the knowledge to formulate the problem), design objectives, and work plan, and preliminary results if possible.

Project Title:			
Student name:			
Student ID:			
Learning objective (LO)	description	ABET Outcomes	Assessment (rate from 1-10)
LO1: Project identification and selection	Identifying a real engineering problem and the most relevant needs and operational constraints and analyze a project statement	#	
LO2: Background review	Gathering and reviewing related data such as technical information, regulations, standards, and operational experience from credible literature resources and knowledge drawn from previous courses and information	A, B	
LO3: Problem formulation	Covering methodology of integrating knowledge and addressing realistic constraints (such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability), and generating possible design options and solutions	#	
LO4: Design objectives and evaluation	Defining design objectives, design constraints, measure of design quality, evaluation criteria of the final project, and reformulate the problem based on collected data	E	
LO5: Project planning	Planning an appropriate an effective project work plan, using standard project planning techniques, to ensure project completion on time and within budget	#	
LO6: <i>Work attitude: a)</i> Contribution to work and Taking responsibility	Demonstrate ability to achieve project objectives while acting as an effective member of a multidisciplinary team	d	
LO6: <i>Work attitude: b)</i> Valuing other views and Conflict resolution:			
Supervisor assessment: 70 marks			
Semester work evaluation (written & oral): 20 marks			
Student peer assessment of work attitude: 10 marks			
Total Assessment: 100 marks			
Remarks:			
Supervisor (s) name and signature (s):			

IE 497 Project-2 Supervisor Assessment Form



The assessment is based on learning objectives for part 1 of the project which includes: problem identification, background review, and problem formulation (use of background and integrate the knowledge to formulate the problem), design objectives, and work plan, and preliminary results if possible.

Project Title:			
Student name:			
Student ID:			
Learning objective (LO)	description	ABET Outcomes	Assessment (rate from 1-10)
LO1: Implementing project parameters and assumptions	Identify design parameters as well as assumptions	a, and/or b	
LO2: Design analysis and/or experimental design	Carry out initial design calculations using modern engineering tools/ and or design of experimental setup and use of its tools	c, k	
LO3: Performance parameters estimation and/or experimental analysis of Design and/or experimental	Use modern engineering tools to estimate and/or to explain a reliable experimental setup for obtaining the performance parameters and trade-off studies and a final optimized analysis	d, k	
LO4: Evaluation of relevant constraints in particular environmental and health issues (3)	Explain efficient measures to deal responsibly relevant constraints (such as: social, economic, health and safety, manufacturability, sustainability, environmental, political and ethical constraints)	f, h, j	
LO5: Evaluation of analysis of design criteria (4)	Evaluate the project related realistic constraints and project success in satisfying the needs, criteria and operational constraints	h, i, c and/or e	
LO6: <i>Work attitude: a)</i> Contribution to work and Taking responsibility	Demonstrate ability to achieve project objectives while acting as an effective member of a multidisciplinary team	d	
LO6: <i>Work attitude: b)</i> Valuing other views and Conflict resolution:			
Supervisor assessment: 70 marks			
Semester work evaluation (written & oral): 20 marks			
Student peer assessment of work attitude: 10 marks			
Total Assessment: 100 marks			
Remarks:			
Supervisor (s) name and signature (s):			

Grading of design project

Final Grading (100 marks)

- 1) **Two examiners** fill assessment forms and submit to project coordinator before oral representation.
 - a) Examiner evaluation of learning outcomes **LO1 to 5** (50 marks)
 - b) Examiner evaluation of the written communication learning Outcome **LO6** (20 marks)
 - c) Examiner project evaluation as capstone design project (10marks)
- 2) **Student set for oral representing the work using PowerPoint.** Examiner evaluation of the oral communication learning outcome **LO7-8** (20 marks)

IE496 Project-1 Examiner Assessment Form

The assessment is based on learning objectives for part 1 of the project which includes: problem identification, background review, and problem formulation (use of background and integrate the knowledge to formulate the problem), design objectives, and work plan, and preliminary results if possible.

Project Title:

Student name:

Student ID:

Learning objective (LO)	Description	ABET Outcome	Assessment rate from 1-10
LO1: Project identification and selection	Identifying a real engineering problem and the most relevant needs and operational constraints and analyze a project statement	A	
LO2: Background review	Collecting and reviewing related data such as technical information, regulations, standards, and operational experiences from credible literature resources and knowledge drawn from previous courses and information	A,B	
LO3: Problem formulation	Covering methodology of integrating knowledge and addressing realistic constraints (such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability), and generating possible design options and solutions	B	
LO4: Design objectives and evaluation	Defining design objectives, design constraints, measure of design viability, evaluation criteria of the final project, and reformulate the problem based on collected data	B	
LO5: Project planning	Planning an appropriate an effective project work plan, using standard project planning techniques, to ensure project completion on time and within budget	B	
LOF <i>Written communication skill: a)</i> Style, Formatting, organizing & language neatness	Communicate design details and express thoughts clearly and concisely, in writing, using necessary supporting material, to achieve desired understanding and impact.	A,B	
LOF <i>Written communication skill: b)</i> Content & Relevance			
LOB <i>Oral communication skill: a)</i> Style content, Styling, Organizing, Visual aid & neatness	Communicate design details and express thoughts clearly and concisely orally, using necessary supporting material, to achieve desired understanding and impact. Oral communication includes delivery skill & Audience response	A,B	
LOB <i>Oral communication skill: b)</i> Delivery skill & Audience response			

Assessment: **90 marks**

Examiner evaluation on project as a capstone design project: **10 marks**

Total mark: **100 marks**

Remarks:

External examiner name and signature:

Coordinator name and signature:

IE497 Project-2 Examiner Assessment Form

The assessment is based on learning objectives for part 1 of the project which includes: problem identification, background review, and problem formulation (use of background and integrate the knowledge to formulate the problem), design objectives, and work plan, and preliminary results if possible.

Project Title:

Student name:

Student ID:

Learning objective (LO)	Description	ABET Outcome	Assessment rate from 1-10
LO1: Implementing project parameters and assumptions	Identify design parameters as well as assumptions	C, and/or D	
LO2: Design analysis and/or experimental design	Carry out initial design calculations using modern engineering tool/ and/or design of experimental setup and use of its tools	C, B	
LO3: Performance parameters estimation and Optimized analysis of Design and/or experimental	Use modern engineering tools to estimate and/or to explain a reliable experimental setup for obtaining the performance parameters and trade-off studies and a final optimized analysis	C, B	
LO4: Evaluation of relevant constraints in particular environmental and health issues (5)	Explain efficient measures to deal responsibly relevant constraints (such as: social, economic, health and safety, manufacturability, reusability, environmental, political and ethical constraints)	F, H, I	
LO5: Evaluation of analyses of design criteria (4)	Evaluate the project related realistic constraints and project success in satisfying the needs, criteria and operational constraints	H, I, C, and/or D	
LOF <i>Written communication skill: a)</i> Style, Formatting, organizing & language neatness	Communicate design details and express thoughts clearly and concisely, in writing, using necessary supporting material, to achieve desired understanding and impact.	A, B	
LOF <i>Written communication skill: b)</i> Content & Relevance			
LOB <i>Oral communication skill: a)</i> Style content, Styling, Organizing, Visual aid & neatness	Communicate design details and express thoughts clearly and concisely orally, using necessary supporting material, to achieve desired understanding and impact. Oral communication includes delivery skill & Audience response	A, B	
LOB <i>Oral communication skill: b)</i> Delivery skill & Audience response			

Assessment: **90 marks**

Examiner evaluation on project as a capstone design project: **10 marks**

Total mark: **100 marks**

Remarks:


External examiner name and signature:

Coordinator name and signature:


IE - Capstone Design Project

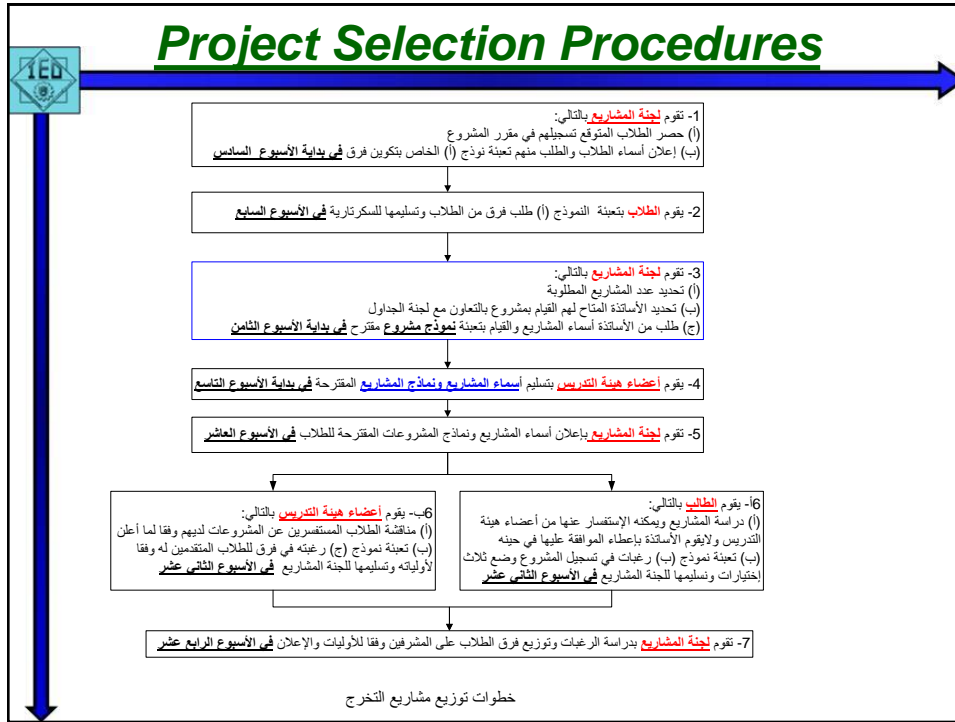
Selection Procedures

and proposal form (PPF)



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Project Selection Procedures

الجدول الزمني لعملية تسجيل مشروع التخرج



الفصل الدراسي الثاني 1432 - 1433

التوقيت	1	2	3	4
الأسبوع الثالث	تحديد المتقدمين للمشروع المسجلة في الفصل الثاني			
الأسبوع الرابع	الحصول على قوائم توقعات تسجيل الطلاب في الفصل القادم			
الأسبوع الخامس	محاضرة لتوضيح خطوات التسجيل لتوقعي التسجيل في المشروع			
الأسبوع السادس	حصر الطلاب المتوقع تسجيلهم لمقرر المشروع في الفصل القادم	إعلان قائمة بأسماء الطلاب المتوقع تسجيلهم لمقرر المشروع في الفصل القادم (أ)	حداية فترة تعبئة نموذج تكوين فرق عمل	
الأسبوع السابع	محاضرة عامة للأساتذة لتوضيح ما هو المضمون المرجو من مشروع التخرج حسب "أبي" Capstone Design According to ABET	نهاية فترة تعبئة نموذج تكوين فرق عمل (أ)		
الأسبوع الثامن	حصر عدد المشاريع المطلوبة	تحديد أعضاء هيئة التدريس المأخوذ لهم الإشراف على مشاريع	إعلام أعضاء هيئة التدريس الذين تم تحديدهم للإشراف على مشاريع لتبدء في تعبئة نموذج مقترح مشروع	
الأسبوع التاسع	استلام نماذج مقترح المشروع من أعضاء هيئة التدريس			
الأسبوع العاشر	إعلان أسماء المشاريع ونماذج مقترحاتها للطلاب			
الأسبوع الحادي عشر	دراسة المشاريع المقترحة ومناقشة أعضاء هيئة التدريس فيها	أعضاء هيئة التدريس: الرد على استفسارات الطلاب فيما يخص المشاريع المقترحة	تعبئة نموذج رغبات تسجيل مشروع (ب) بتحديد ثلاثة مشاريع براتب افضلية التسجيل	تعبئة نموذج رغبات فرق الطلاب بتحديد ثلاثة فرق طلابية براتب افضلية الإشراف
الأسبوع الثاني عشر	دراسة رغبات الطلاب وأعضاء هيئة التدريس وتنسيق فرق الطلاب وفقاً للرغبات التي تم تحديدها في كلاً من نموذجي (أ) و (ب) و (ج)			
الأسبوع الرابع عشر	إعلان القائمة النهائية لفرق المشاريع متضمنة أسماء المشاريع المسطرة وأسماء أعضاء هيئة التدريس المشرفين عليها			

لجنة بطون الخريجين ومشاريع التخرج

13-02-12

Project Proposal Form (PPF)

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(PPF)

Note: Teaching staff write (PPF) to be presented to the students. Accordingly, a design team will be formed, and the teams will respond with a proposal detailing how they will carry out the design project.

<p>1- Project Title: Design of Database for Automotive Parts</p>
<p>2- Supervisor (Mentor) Name (s): Abdulrahman Al-Ahmari, Abdulaziz Al-Tamimi</p>
<p>3- Background: Brief explanation of the project, the needs, and motivations for this effort. The knowledge for automobile parts are gathered and arranged based on product structure for various car systems to have better understanding of car and when developing the data base. The database is build using access software containing set of characteristics and factors of part functionality (using function recognition techniques such as IDFO, ...) and including part drawing. The database is to be linked with set of rules developed using visual basic for decision making process of selecting car parts. The project will provide the experience of building database and knowledge based system drawn from knowledge learned from IE413, IE433, IE490, and general knowledge of other courses. Also, the students will be able to understand the required product design components and determining their specifications.</p>
<p>4- Objective: brief explanation of what to be accomplished in the project? Developing automobile parts data base and its knowledge system for part selection.</p>
<p>5- Project Requirements: List all requirements necessary to carry out project. A brief specific detail should also be given such as:- No. of students: 3 students Materials: Reading material (information system – database design – Car design and product – classification methods – functioning analysis) Instruments: Equipment: Computer - printer Software: Access – visual basic – IED program Others:</p>
<p>6- Project Realistic Constraints: Briefly state which realistic constraints will be addressed (social, economical, health and safety, manufacturability, sustainability, environmental, political and ethical constraints). The project is mainly addressing economical, manufacturability, environmental and ethical issues. The student should explain how these constraints apply to their project and how they will be addressed in the project.</p>

Semester No. = 1st 1430/1431 1

- ## Project Proposal Form (PPF) Content
- **Project Title:** suggest title for the project (make it as short as possible)
 - **Contact:** The name of the contact or mentor for the student team. If the project is for a company please include that information.
 - **Background:** Brief explanation of the project, the needs, and drivers for this effort.
 - **Objective:** What is to be accomplished in the project?
 - **System Requirements:** state in broad and simple terms. The specific details will be established between the client and the team.
 - 1)
 - 2)

Project Proposal Form(PPF) Content



- **Deliverables:** indicate the desired deliverables in the project. The final deliverables will be established through negotiations between the team and the client.
- **Technical Requirements:** suggest the skill areas the students may need in order to complete the project.
- **Customer Commitments:** state the expected commitments to make available to ensure successful completion of the project.
- **Realistic Constraints:** state the expected constraints to be addressed
- **Additional Requirements:**

Project Proposal Form(PPF) Content



- Staff should fill the form and after team is assigned; the project should explained in details to students.
- At start the students should carry out the following by mentor help;
 1. **Project planning activity: to provide a work plan as Gantt chart**
 2. Explain how this project would address the ABET requirements of incorporating engineering standards and realistic constraints in these areas

Example of Realistic Constraint

Area	Codes & Standards / Realistic Constraints
economical	
environmental	
political	
social	
ethical	
health and safety	
manufacturability	
sustainability	